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# Studies of Energetics and Symmetry in Gas-Filled Hohlraums*

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Gas-filled hohlraum targets are proposed for achieving ignition on the National Ignition Facility (NIF) [1]. Studies of radiation drive [2] and implosion symmetry [3] in vacuum hohlraums have demonstrated quantitative agreement between measurements and detailed simulations. Experiments are now being performed with the Nova laser using methane- and propane-filled hohlraum targets to assess the effect of gas fill on radiation drive and symmetry tuning and to verify modeling of NIF gas-filled hohlraums.

Experiments to date suggest that descrepancies between gas hohlraum simulations and observations are primarily due to parametric processes. The intensity patterns produced at the laser entrance hole using current Nova f/4 beams have ~35% of the energy in hot spots with intensity greater than $1X10^{16}$ Watts/$cm^2$. These hot spots intensities exceed the calculated thresholds for the onset of parametric instabilities in the gas. Observations of increased stimulated scattering and modified radiation emission patterns suggest that parametric processes are indeed important.

Hohlraum energetics is assessed from time-resolved measurements of frequency-dependent radiation flux from the hohlraum wall, stimulated Brillouin and Raman backscattered energy and spectra, and electron temperature in the hohlraum interior from spectroscopic techniques and Thomson scattering. The peak measured radiation drives in methane- and propane-filled hohlraums are reduced compared to vacuum hohlraums and simulations not including parametric losses, but the measured drive reductions are consistent with the observed levels of backscatter. The calculated plasma temperatures agree with observations during the peak of the laser drive with some differences in the detailed time histories.

Time-integrated implosion symmetry experiments image x-ray self-emission from dopants in the capsule fuel to monitor changes in capsule distortion as the axial beam pointing position along the hohlraum wall is varied. These measurements [4] have verified our ability to produce symmetric implosions with optimal beam positioning and show the calculated sensitivity to variations in beam pointing position. The pointing position corresponding to best symmetry tuning, however, is shifted by 120±40 microns compared to vacuum hohlraums and simulations.

In complementary experiments, direct imaging of thermal and m-band x-ray emission from the hohlraum wall provides direct evidence that radiation emission pattern in gas-filled hohlraums differs from simulations and vacuum hohlraums. An outward shift in the position of peak emission is observed early in time, and beam spreading towards the laser entrance hole is observed throughout the laser pulse. These observations and modeling results suggest that the small observed shift in implosion symmetry with gas results from these subtle changes in the hohlraum radiation pattern. Beam steering in the direction of the plasma flow by density depressions associated with filamentation has been proposed as a mechanism for producing the observed outward shift in the emission pattern [5,6].

Auxiliary experiments have been performed in which a single beam of Nova is spatially smoothed with a random phase plates (RPP) and in some cases temporal smoothing by spectral dispersion (SSD) to assess the role of laser hot spots. These measurements suggest that spatial smoothing alone is adequate to achieve nominal drive and symmetry in methane-filled hohlraums. Measured backscatter levels are reduced to a few per cent with RPP smoothing. Analysis indicates that spatial beam smoothing is adequate to produce nominal x-ray emission patterns in methane-filled hohlraums. Work is ongoing to assess the role of temporal (SSD) beam smoothing for higher density gas fills. Based on these results, work is proceeding to implement smoothing on all ten beams of Nova. Gas-filled hohlraum energetics and symmetry measurements with 10-beam smoothing are planned for late-1996.


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